Improved Tools to Locate Buried Gas Pipes in Congested Undergrounds

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Project Participants

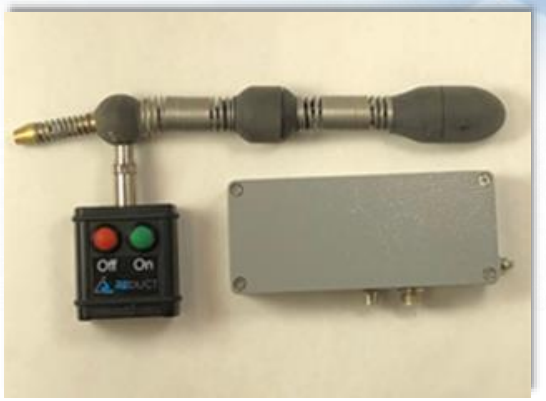
- The project team would like to thank the funding partners: Pipeline and Hazardous Materials Safety Administration (PHMSA) and Operations Technology Development (OTD)
- The project team was comprised of members from GTI, Reduct, and Condux/Prisum. Specific individuals are listed below:
  - Trey Benincosa, Ph.D. (GTI)
  - Dennis Jarnecke (GTI)
  - Jason Sphar (GTI)
  - Jeff Mainzer (GTI)
  - Frank Hennessey (GTI)
  - Otto Ballintijn (Reduct)
  - Hans Van Nieuwenhuyze (Reduct)
  - Daan Tamsyn (Reduct)
  - Santosh Saride (PRISUM)

Improved Mapping Tools are Needed to Mitigate Third-party Pipeline Damage

- Excavation damage continues to be a leading cause of pipeline incidents. Pipeline incidents caused by excavation damage can result in fatalities and injuries, as well as significant costs, property damages, environmental damages, and unintentional fire or explosions.
- A mapping technique is needed to identify the location of underground assets prior to construction activities or excavations.
- This device must be able to map live underground pipes and provide accurate spatial positioning without obstructing the flow of gas.

Live-Gas Pipeline Mapping

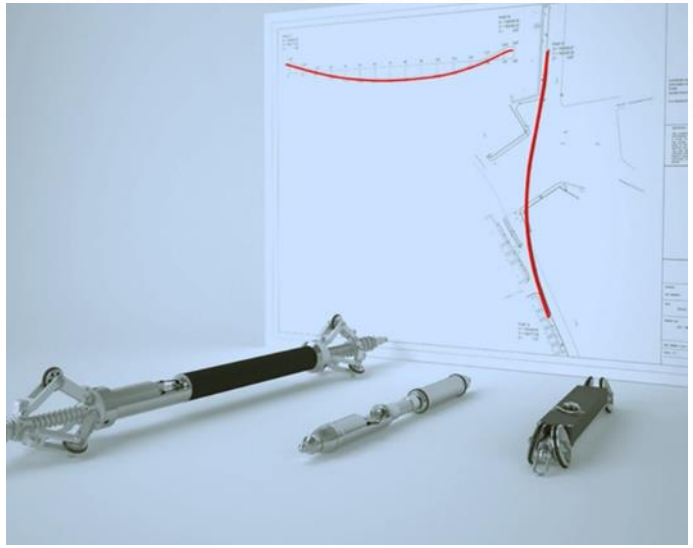
- To provide the natural gas industry with a new tool to assist with mapping needs, a mapping probe that can be inserted into a live gas pipe through a Jameson launching tool was developed.
- The probe can be inserted through a hot tap entry system and collect data from within the pipe without blowing gas to the atmosphere and interrupting service to downstream customers.
- The probe collects 3-dimensional x, y, and z geospatial data.

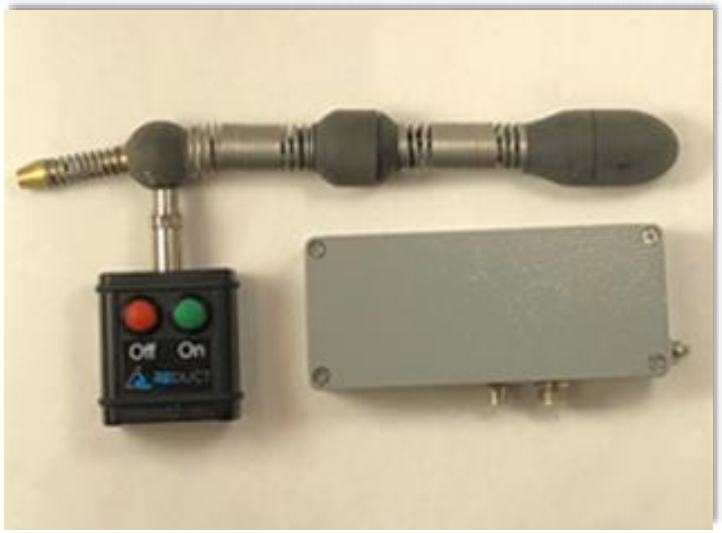


Project Structure

- The project was broken into the following 8 tasks:
  - Task 1 - “Project Scoping” is to review project goals and objectives and kick-off the project with team members and stakeholders.
  - Task 2 - “Enhance Existing Technology” is to enhance the existing smart probe design to allow it to be inserted into a live natural gas line.
  - Task 3 - “Create a New Access Fitting” is to design and manufacture a 90° fitting that will allow the new probe to navigate into a live pipe.
  - Task 4 - “Cloud Based Data Collection and GIS Development” is to develop a system that can easily upload field data from the probe into the cloud and can be easily retrieved by utilities.
  - Task 5 - “System Evaluation” is to conduct pipeline mapping in a live pressurized gas pipe.
  - Task 6 - “Utility Testing of Geospatial Mapping Technology” is to conduct field trials with the enhanced prototype at one additional local gas distributors live gas lines.
  - Task 7 & 8 “Project Management and Reporting”
- PHMSA Project Funding: $502,000

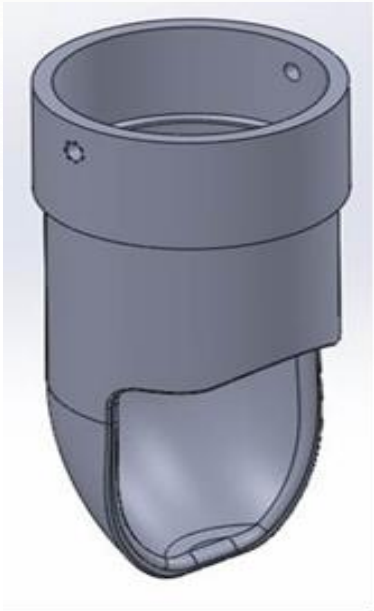
Task 2 – Enhance Existing Technology





- Reduct's existing "Ductrunner" technology can map unoccupied conduits or decommissioned pipelines, however, 90° entry into a 2" pipe was a new spatial challenge.
- The team successfully re-designed the sensor system to accommodate the new entry and propulsion method.

Task 3 – Create New Access Fitting



- The probe required a new access fitting and entry system components to direct the probe in the preferred direction of travel while meeting the spatial requirements of 2” pipeline and the payload of sensors.
- An access fitting and entry system components were developed that is compatible with the existing Jameson launch tool and can bi-directionally guide the mapping probe in the preferred direction.

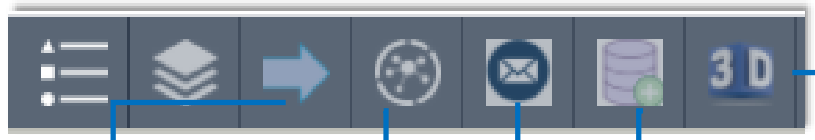
Task 4 – Cloud-based Data Collection and GIS Development

Output CSV File

Distance_	Easting	Northing	Depth	Azimuth	Pitch
0	1095724	1950015	0	0	0
1.7	1095726	1950015	0.038	77.8	1.3
2	1095726	1950015	0.042	77.1	0.7
3	1095727	1950015	0.064	77.6	1.3
4	1095728	1950016	0.108	78	2.5
5	1095729	1950016	0.135	78.9	1.6

Python Scripts

GeoProcessing Services



Convert Data to 3D

Convert CSV to Points and Line

Export Data to Portal

Email Data as Zip File

Export Data to Enterprise SDE

- The mapping data collected from the probe needed to be easily accessible to a gas utilities Geographic Information System (GIS)
- The team leveraged Esri web application tools to store, distribute, and view (in 2D and 3D) the mapping data collected by the probe.

Task 5 – System Evaluation

- The team sequentially tested the integrated system on empty and then pressurized pipe easily mapping 300 ft in one direction (tool can travel in both directions from one horizontal entry into the pipe).
- These trials led to the development of the initial prototype used for the live-demonstrations.

Task 6 – Utility Testing of the Geospatial Mapping Technology

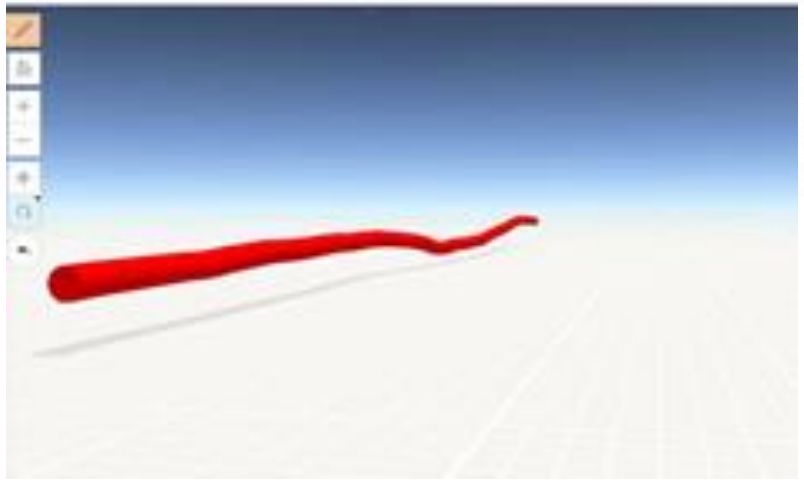
- The team performed 5 live demonstrations with Pacific Gas and Electric, Peoples Gas and Light, RoundTable Live – Manteno, IL, City Utilities – Springfield, MO, and Ameren to test the effectiveness of the system on 2 and 4” pipe and collect feedback from natural gas operators (end users).

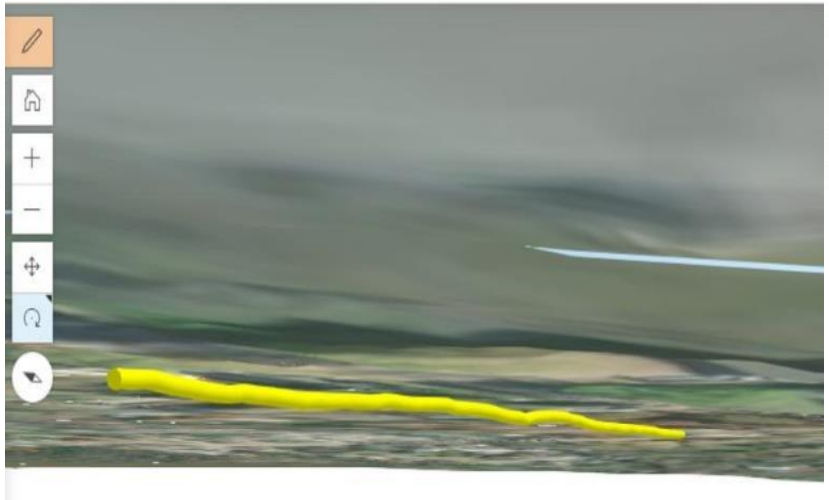
Results

The following includes the results achieved from the live demonstrations:

- The Live Gas Mapping System successfully collected ~ 209 ft of 3D data on a live 2” gas main in a residential neighborhood in Springfield, MO.
- The integrated system can achieve at least 600 ft of pipeline mapping.
  - This mark was an internal team goal and a limitation of lab space to perform testing. The maximum length is still undetermined.
- Mapping campaigns on live natural gas pipes operating at pressures up to 60 psig.
- The system has been tested in 2” and 4” pipes.
- A new workflow was developed to manage and view 3D data leveraging Esri web application tools

Conclusions





- A new mapping tool has been developed that can collect x, y, and z 3D data from inside the pipe.
- The system alleviates challenges with surface locating technologies such as soil and pavement conditions, pipe material, pipe content, and interference from adjacent utilities.
- The system is compatible with existing hot tap entry equipment which will ease adoption into a gas utilities operations.
- Various pipe sizes and types can be used (plastic, steel, cast iron, etc.)
- The tool should be used to provide location data when tracer wires are broken on existing (unlocatable) plastic pipes.
- Bi-directional travel enables the collection of 3D data at one entry point during a pipe excavation or daylighting activity.
- More accurate mapping can support: damage prevention initiatives, accurate mapping of piping prior to construction work (i.e., road reconstruction or utility work), accurate GIS for existing infrastructure

Technology Transfer

- Presentations were delivered at Esri's Infrastructure Management and GIS Conference, and GTI's GIS Week.
- Reduct has refined the prototype and produced a commercial version for continued demonstrations.
- PRISUM will be leading the U.S. distribution of the mapping tool.

Questions?

- Contact Information: Trey Benincosa, Ph.D. 847-971-0478, tbenincosa@gti.energy
- The Final Report and this Presentation can be found at the project webpage: https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=734
- Thank you for attending and special thanks again to our project sponsors and partners.